AN INVESTIGATION OF BODY COMPOSITION IN PEOPLE WITH AND WITHOUT CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

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A thesis submitted for the degree of Master of Philosophy (Medicine)

University of Newcastle

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STATEMENT OF ORIGINALITY

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to the final version of my thesis being made available worldwide when deposited in the University’s Digital Repository, subject to the provisions of the Copyright Act 1968.

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Joanne M Smart
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### ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>6MWT</td>
<td>6 Minute Walk Test</td>
</tr>
<tr>
<td>ASMMI</td>
<td>Appendicular Skeletal Muscle Mass Index</td>
</tr>
<tr>
<td>BIA</td>
<td>Bioelectrical Impedance Analysis</td>
</tr>
<tr>
<td>BMC</td>
<td>Bone Mineral Content</td>
</tr>
<tr>
<td>BMD</td>
<td>Bone Mineral Density</td>
</tr>
<tr>
<td>BMI</td>
<td>Body Mass Index</td>
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<tr>
<td>COPD</td>
<td>Chronic Obstructive Pulmonary Disease</td>
</tr>
<tr>
<td>CRP</td>
<td>C Reactive Protein</td>
</tr>
<tr>
<td>CT</td>
<td>Computed Tomography</td>
</tr>
<tr>
<td>DEXA</td>
<td>Dual-Energy X-ray Absorptiometry</td>
</tr>
<tr>
<td>DHA</td>
<td>Docosahexaenoic Acid</td>
</tr>
<tr>
<td>ELISA</td>
<td>Enzyme-Linked Immunosorbent Assay</td>
</tr>
<tr>
<td>eNO</td>
<td>Exhaled Nitric Oxide</td>
</tr>
<tr>
<td>EPA</td>
<td>Eicosapentaenoic Acid</td>
</tr>
<tr>
<td>FEF$_{25-75%}$</td>
<td>Forced Expiratory Flow 25 – 75%</td>
</tr>
<tr>
<td>FEV$_1$</td>
<td>Forced Expiratory Volume in one second</td>
</tr>
<tr>
<td>FFM</td>
<td>Fat Free Mass</td>
</tr>
<tr>
<td>FFMI</td>
<td>Fat Free Mass Index</td>
</tr>
<tr>
<td>FFQ</td>
<td>Food Frequency Questionnaire</td>
</tr>
<tr>
<td>FM</td>
<td>Fat Mass</td>
</tr>
<tr>
<td>FVC</td>
<td>Forced Vital Capacity</td>
</tr>
<tr>
<td>GSH</td>
<td>Glutathione</td>
</tr>
<tr>
<td>HRQoL</td>
<td>Health Related Quality of Life</td>
</tr>
<tr>
<td>IL</td>
<td>Interleukin</td>
</tr>
<tr>
<td>IPAQ</td>
<td>International Physical Activity Questionnaire</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>LTB₄</td>
<td>Leukotriene Beta 4</td>
</tr>
<tr>
<td>MET</td>
<td>Metabolic Equivalent Task</td>
</tr>
<tr>
<td>MRI</td>
<td>Magnetic Resonance Imaging</td>
</tr>
<tr>
<td>mRNA</td>
<td>Messenger Ribonucleic Acid</td>
</tr>
<tr>
<td>MSWT</td>
<td>Modified Shuttle Walk Test</td>
</tr>
<tr>
<td>n-3 LC</td>
<td>Omega-3 Long Chain</td>
</tr>
<tr>
<td>OAD</td>
<td>Obstructive Airway Disease</td>
</tr>
<tr>
<td>PGE₂</td>
<td>Prostaglandin E₂</td>
</tr>
<tr>
<td>PUFA</td>
<td>Polyunsaturated Fatty Acid</td>
</tr>
<tr>
<td>RMR</td>
<td>Resting Metabolic Rate</td>
</tr>
<tr>
<td>ROS</td>
<td>Reactive Oxygen Species</td>
</tr>
<tr>
<td>SaO₂</td>
<td>Arterial Oxygen Saturation</td>
</tr>
<tr>
<td>SGRQ</td>
<td>St George’s Respiratory Questionnaire</td>
</tr>
<tr>
<td>TLC</td>
<td>Total Lung Capacity</td>
</tr>
<tr>
<td>TLR-4</td>
<td>Toll Like Receptor 4</td>
</tr>
<tr>
<td>TNF-α</td>
<td>Tumour Necrosis Factor-Alpha</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organisation</td>
</tr>
</tbody>
</table>
ABSTRACTS:


2. **Smart JM**, Wark PA, McDonald VM, Wood LG. Low levels of body fat and obstructive airway disease in ex-smokers. Australasian Medical Journal. (Perth, Australia, December 2010 – oral presentation)

3. **Smart JM**, Wark PA, McDonald VM, Wood LG. Body composition in ex-smokers with and without airflow obstruction. Obesity Research & Clinical Practice. 4: S30; 2010. (Sydney, Australia, October 2010 – poster presentation)

SYNOPSIS

Chronic Obstructive Pulmonary Disease (COPD) is a chronic lung disease, characterised by poorly reversible airflow limitation that is usually progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases, particularly cigarette smoke. The primary risk factor for COPD is cigarette smoking. Airway and systemic inflammation are features of COPD. The increasing prevalence and burden of COPD leads us to look at other factors that may influence the development and progression of COPD.

Body composition, in particular low levels of fat free mass (FFM) is associated with worse survival and/or severity of COPD. Determinants of body composition include lifestyle factors such as dietary intake, physical activity patterns and smoking status, as well as age and gender. This thesis aimed to firstly examine the association between body composition, inflammation and lung function in healthy controls versus ex-smokers with or without COPD (Chapter 2). Secondly, it aimed to examine dietary intake, physical activity and inflammation as determinants of body composition in ex-smokers (Chapter 3).

In Chapter 2, positive associations were observed between total and regional lean muscle mass and bone mineral content (BMC) and lung function in ex-smokers. Conversely negative associations were observed between body fat mass and lung function in ex-smokers. An increase in body mass index (BMI) was associated with an increase in body fat, lean muscle mass and BMC in ex-smokers without COPD. This was not seen in those with COPD, with the presence of disease appearing to modify the effects of weight gain. Lean muscle mass was also associated with better perceived quality of life and found to be negatively associated with systemic inflammation (CRP, IL-6, leptin).
In Chapter 3, a positive association between lean muscle mass and dietary intake of nutrients found in fruit, vegetables, whole grains and fish was identified. Conversely, a negative association was observed between total body fat mass and dietary intake of nutrients found in fruit, vegetables, whole grains and fish. Dietary fat intake, physical activity and systemic inflammation were strong predictors of total body lean and fat mass in ex-smokers, but were not predictors of total body BMC.

The protective effect of a high BMI in COPD does not appear to be due to an increase in fat mass but due to the presence of lean muscle mass. Reducing dietary fat intake, increasing physical activity and reducing systemic inflammation were identified as potential modifiable factors to improve and maintain lean muscle mass in ex-smokers. Assessment of diet and physical activity should be included in the management and care of those at risk of and those with COPD. Interventions targeting inflammation such as statins, omega-3 fatty and antioxidants may further improve outcomes in those ex-smokers with COPD.